ENGINEERING



Danfoss Cooling & Refrigerant perspective

Let's bring the refrigerant transition down to earth

Agenda





- Regulations/timeline
- View on refrigerants

Section 2 – Danfoss Cooling

- Commercial A/C
- Commercial Refrigeration
- Food Retail

Timeline for Standards and Codes





Worldwide Energy and Refrigerant Regulations

The main drivers for new designs

			Focus of	next 2 year	S		
			2015	2017	2019	2022	2024
-	ENER LOT1 Heating Sys	SCOP	Tier 1	Tier 2			
U R	ENER LOT21 A/C Sys	SEER/SEPR		Tier 1	Tier 2		\rightarrow
O P	ENTR LOT1 Refriger. Eq.	COP/SEPR	Tier 1	Tier 2			\rightarrow
E	F-Gas Phase-down	2009-12 CO2eq BaseLine	-7%	-37%	-55%	Review	-69% >
				1 1 1			
	ASHRAE 90.1 Chillers	EER/IPLV	Enforced	Next level?	Next level?		Next level?
U	90.1/ DOE Rooftops	EER/IEER		Step1		<u> </u>	Step2 >
S A	DOE 10 CFR (429-431)	MDEC/AWEF		CRE Ice VI	END/Mics.Ref Cold Ro	oms	>
	EPA/ SNAP rules	Ref. delisting by application		Super- markets CU	Stand- alone	California?	Petitions for chillers / rooftops <700 GWP
				1			
	GB 19577 Chillers	COP/IPLVc		Expected			Heating
C H T	GB xxx	COP/IPLVh		Expected			A/C
N A	Low Amb. HP MP phase down	-	HCFCs -> HFCs	1 1 1 1 1	HFCs -> Lo	w GWP	Refrigeration

4 | Danfoss Cooling | Danfoss Refrigerant Week | Air Conditioning | Sept. 2017

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F-Gas directive: GWP limits & consequences

Ban in new equipment	GWP limit	From 1 st Jan	Consequences
Commercial Refrigerator and Freezers,	≤ 2500	2020	Ban of R404A/507 Use of HC, HFO eg R448A, R449A, R452A
BAN 11	≤ 150	2022	Ban of R134a Use of HC, HFO
Stationary refrigeration equipment for temperatures above -50° C BAN 12	≤ 2500	2020	Ban of R404A/507 Use of HC, H-FKW, HFO eg. R448A, R449A, R452A, R134a
Multipack centralized refr. systems for commercial use with a capacity ≥ 40kW BAN 13	≤ 150 and ≤ 1500 Primary circuits of cascade systems	2022	Ban of R404A/507 Use of R134a in cascade systems, HFO, CO ₂



HFC and HFO's in play







Main refrigerants in Play a Picture in Continuous Evolution





Refrigerant Sustainability Triangle





Agenda

Section 1 – Introduction

- Regulations/timeline
- View on refrigerants
- Section 2 Danfoss Cooling
- Commercial A/C
- Commercial Refrigeration
- Food Retail

Long-term refrigerant strategy Air Conditioning



The air conditioning segments are moving to low and medium GWP and natural refrigerants



Chillers and Rooftops

Portfolios and regulations (Scroll, centrifugal, screw or recip.)

Available in > 2017 > 2018 / onwards							
Portfolio per chiller type	Scroll			Centrifugal and screw			
alternatives	R410A	R32	R452B	R134a	R1234ze	R513A	
Controls	Thermostatic glasses, ball v switches, elec	and electronic valves, pressur ctronic controlle	expansion va e & temperatu ers*	lves, solenoid valv ure regulating valv	ves (new EVR ves, water va	.), sight Ives,	
Fixed-speed compressors	Scrolls Scrolls with IDVs Scrolls for Heating	Scrolls with I	OVs				
Scrolls and Oil- Free Variable-speed compressors	VZH inverter Scrolls Hybrid manifold scrolls	Inverter scroll	s with IDVs	TT series VTT series	<mark>TG series</mark> VTT series	TT series VTT series	
Heat Exchangers	Micro-channe	l, micro-plate h	neat exchange	ers			

*valves qualified for R32 & R452B refrigerants only below 25mm today



Your source for HVAC solutions



The technology in our Micro Channel and Micro Plate Heat Exchangers helps to make a difference in terms of energy consumption and refrigerant charge.





Electronics and sensors

Use the Danfoss MCX programmable controller for maximum flexibility and the Danfoss EKE superheat controller with temperature and pressure sensors to fine tune any chiller's output to your desired specifications.



Danfoss system protectors have been thoroughly tested in our labs & in the field in order to guarantee trouble-free operation during your system's lifetime.

Danfoss Extensive portfolio of AC Drives dedicated for chiller compressors, fans and pumps incl. low harmonic AFE drives and medium voltage drives, ranges from 0.55kW to 7MW

AC Drives

Ξ

VRF

From our TGE valve to the ETS Colibri line, Danfoss has extensive experience in thermostatic and electric valves with proven track records of performance, quality, and durability.

Valves



Danfoss compressors range from 3 to 350TR and offer the widest technology options to address new regulations.



Long-term outlook Refrigeration





Stationary refrigeration equipment Application: remote condensing unit cold rooms



Available in 2017 Available in 2018

F-Gas impact:

- Phase down of high GWP refrigerants (i.e. R404A)
- Ban 12: ban of R404A in new equipment:
 - GWP limit to 2500 from January 2020
 - > Alternative refrigerants: R407A/F, R448/9A, R452A

Danfoss portfolio with alternative ref.	R407A/ R407F	R448A/ R449A	R452A	R290	R134a	R450A	R513A
Fixed speed compressors	✓ MBP recips & scrolls	 ✓ MBP recips & scrolls ✓ LBP scrolls 	 ✓ LBP recips & scrolls ✓ MBP recips • MBP scrolls 	• MBP recips	✓ MBP recips & scrolls	MBP recips & scrolls	MBP recips & scrolls
Variable speed compressors	 ✓ MBP recips & scrolls 	✓ MBP scrolls			✓ MBP recips		
Fixed speed fractional compressors		✓ MBP R449A within limits	✓ MBP & LBP within limits	✓ MBP & LBP	✓ MBP		
Variable speed fractional compressors				✓ MBP & LBP	✓ MBP		
Packaged condensing units	✓ MBP fixed and variable speed ranges	 MBP fixed speed ranges MBP variable speed LBP fixed speed with LI 	 ✓ LBP fixed speed ranges MBP fixed speed 		✓ MBP fixed speed ranges		
Bare condensing units	✓ MBP	✓ MBP	✓ MBP & LBP	✓ LBP• MBP	✓ MBP		
Controls	✓ Thermostatic a regulating valves	nd electric expans , water valves, sw	ion valves, solenoi itches, electronic c	id valves (new EVF controllers	१), sight glasses, b	all valves, pressure	e & temperature
Heat Exchangers	✓ Micro-channel,	micro-plate heat e	exchangers				



Hermetically sealed systems Application: clip-on/plug-in cold rooms



F-Gas impact:

- > **Phase down** of high GWP refrigerants (i.e. R134a and R404A)
- > Ban 11 in 2 steps: ban of R404A and R134a in new equipment
 - In January 2020: GWP <2500</p>
 - Alternative refrigerants: R450A, R513A
 - > R448A, R449A and R452A are also valid until 2020
 - → In January 2022: GWP <150
 - Sustainable refrigerant: R290

Danfoss portfolio with alternative refrigerants	R290	R450A	R513A
Fixed speed compressors	• MBP recips	MBP recips & scrolls	MBP recips & scrolls
xed speed compressors • MBP recips • MBP recips & scrolls • MBP recips & scrolls xed speed fractional ompressors • MBP & LBP Under evaluation to qualify with these refrigerants ariable speed fractional ompressors • MBP & LBP Image: Compressors • MBP & LBP • MBP & LBP Image: Compressors • MBP & LBP • MBP & LBP • MBP & LBP • MBP & LBP • MBP & LBP • MBP & LBP • MBP & LBP • Thermostatic and electric expansion valves, solenoid valves (new EVR), sight glasses, ball valves,	ese refrigerants		
Variable speed fractional compressors	✓ MBP & LBP		
Controls	✓ Thermostatic and electric expans pressure & temperature regulating	ion valves, solenoid valves (new EVI valves, water valves, switches, elect	R), sight glasses, ball valves, tronic controllers
Heat Exchangers	\checkmark Micro-channel, micro-plate heat e	exchangers	

Available in 2017 - Available in 2018



Hermetically sealed systems Application: Food service





Commercial Fridge & Freezer

Glass Door Merchandiser

Commercial Ice Making Machine



Ice Cream & Frozen Beverage Machine

F-Gas impact:

- Phase down of high GWP refrigerants (i.e. R134a and R404A)
- Ban 11 in 2 steps: ban of R404A and R134a in new equipment
 - In January 2020: GWP <2500</p>
 - → Alternative refrigerants: R450A, R513A
 - R448A, R449A and R452A are also valid until 2020
 - > In January 2022: GWP <150
 - Sustainable refrigerant: R290

Danfoss portfolio with alternative refrigerants	R290	R450A	R513A		
Fixed speed compressors	• MBP recips	MBP recips & scrolls	MBP recips & scrolls		
Fixed speed fractional compressors	✓ MBP & LBP	Under evaluation to qualify with the	ese refrigerants		
Variable speed fractional compressors	✓ MBP & LBP				
Controls	✓ Thermostatic and electric expansion valves, solenoid valves (new EVR), sight glasses, ball valves, pressure & temperature regulating valves, water valves, switches, electronic controllers				
Heat Exchangers	✓ Micro-channel, micro-plate heat exchangers				

Available in 2017 - Available in 2018







Food Retail

Technology status

Technology allows for world wide adoption of CO₂ only systems



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3rd generation: Parallel compression with gas ejector Mass flow

- First system in opperation with Danfoss Multi Ejector started in January 2015.
- The ejectors are moving gas from MT suction to parallel compressor.
- In some cases, all gas can be moved from MT to parallel compressor (high ambient temperature or 100% heat recovery).



3rd generation: Parallel compression with gas ejector

Pros:

- System is penetrating the market
- Solutions shows better energy consumption in any climate and removes the "CO₂ equator"
- Compressor sizes are smaller and not as grooving as fast
- Combination with AC makes very good sense

Cons:

- The system is more complex than the booster systems and also parallel compression
- Small systems are difficult because of the compressors divided in to 2 suction groups

Application:

The system fits system sizes from approx. 100-150 kW and up. System can be combined with AC with very good results. Geographically the system can be installed in any climate with lower energy consumption than R404a.



Next generation: Liquid ejector

Add on to transcritical systems

- Liquid ejector systems allow the MT evaporator to be flooded.
- The saving is coming from the higher suction pressure of the compressors.
- Ejector is in this case substituting a pump or other means of removing the liquid from the suction side
- Trials has been running since 2013 with good results. Evaporation temperature is in average raised by 5K.
- Saving is load dependent and dependent on most leaded evaporator





Energy saving CO₂ VS R404A



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Available Resources

24/7 online resources for your refrigerant transition

Refrigerants.danfoss.com

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CoolTools



Converting to the correct refrigerant requires the right refrigerant tools. We created these digital solutions to help you select the right refrigerant for your situation, find a compatible component, and ensure that the refrigerant is installed correctly in the cooling system.

> Low GWP Brochure

- > Retrofit Guideline
- > Coolselector2
- > Low-GWP Tool

CoolSchool



Danfoss offers a variety of educational solutions to help you understand the refrigerant changes and make the the best decisions about how to adapt to them. Watch videos, take online courses, attend webinars - we have something for everyone.

> Refrigerant Videos

- > Danfoss Learning Programs for Refrigerants
- > White Paper

Webinars



Newsletter



SIGN UP



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24/7 online resources for your refrigerant transition

The low GWP brochure

Overview of the Danfoss portfolio

raduci grouping	reduct	resduct description		manud	ALC: NOT	81343	10010		1.11
	AB-PC 788	Advanced pack controllers							
	AR-FC 201/1002	standard pack controllers			1.00				
	AR-CC STOTTO	case controller for electronic expansion volves			1.00				
	AR-CE 210/110/010	case controller for thermostatic expansion volves							
	182 1383	co, gas presaure controllers							
lectronic	MCE	magammable controllers							
" nelloring	IN THE RED THE RED THE	deleter the second s							
	DRETMA DRETTO	recording reperment control en							
	BKC 113	cascade injection with co,							
	EKC 1112	superheut controllers							
	EKC 1M	remperature controllers							
	10.10	siguid level controllers							
	DH/DCI	scrolls with row for air conditioning						12	
	HLI/HCH/IH	scrolls for air conditioning							
empression for	THE .	scrolls heating optimized							
ir conditioning	32	scrolls for air conditioning							
	VIDE	invertier scrolls for air conditioning						100	
	TT. TS. VTT	narbocor of-free-certiffugal compression							
	MIZ	waneurop exciprocating compressor for medium temp.							
	NTZ	wannut op reciprocating compressor for low temp.							
	MLZ	scroll compressor for medium temperature							
ampressors for	u.z	scroll compressor for low temperature							
wingeration	FL/TL/SL/HVML/SC/GW	Light commercial Ac-compresson for Larywar				•			
	CEE/PEC/PEN	variable speed reciprocating compressor for Lar/Mar							
	80	Light commercial Acyrac compression for mobile cooling							
	optima*	condensing units for medium temperature refrigeration							
	optima*	condensing units for low temperature refrigeration							
and ensing units	optimur alim Pack. optimur Plan	condensing units for medium temperature refrigeration							
	optimar sile rack. optimar rise	condensing units for low temperature refrigeration							
	optimum elus evenemente	condensing units for medium temperature refrigeration							
	457	significant and an enders	an and the						



Approach by region and application

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24/7 online resources for your refrigerant transition

Coolselector[®]2

The Danfoss Cool Tools

Refrigerant Slider app

Low-GWP Tool

Retrofit Guideline





bert Batz, Gobbi Agalication Exandimo: Manayan, mogdana, Gibbi Agalication Exangen, Commental Berkögnentien, n Durogeand Pouleen, Specialist, Giobal Lukerstery Technology, Ph.D. Chemistry, Lagye, Agalication Exanitrece Nanagar. n Coches, September 2016

Josick check before network (Nerkent Blaz)
 Bofres starting to network average of the evolved
 defines starting to network average of the evolved
 defines the system can be fore and the only the o

As extension to the "Quick check" and more in detail which scenarios are possible retrofiting a system an shall it means for components and materials. Name to get the 3.System retrofit procedure (Norbert Blatz, Thieny Leave)

Ship by ship galdelises of how to process a system retrolt. As example of a small system which can so larger scale be transferred to more complex systems.

azona o sala de servición de la como a compositiva de la como a como

energymens und for retrolit bot also ne system ar refejerant types which are ne alson with a retainte high temperature nel what it maans to the system and libe denorthed in detailbut also with as ble relation to practice.

